

PRECAMBRIAN QUARTZO-FELDSPATHIC GNEISS FROM THE HERMAN 1A WELL, ERIE COUNTY, OHIO^{1, 2}

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ABSTRACT

Precambrian quartzo-feldspathic gneiss was encountered at an elevation of -3616 feet in the Herman 1A well drilled in southeastern Erie County, Ohio, by the Amerada Petroleum Corporation. The five samples of this gneiss that were studied exhibit varying degrees of gneissose foliation. In order of decreasing abundance, microcline, plagioclase, quartz, and biotite together account for an average of 75% of the mineralogy. Greenish saussuritized plagioclase in layers and veins is abundant in three of the samples. Based on the presence of minor amounts of garnet, a plagioclase composition of An_{36} , and the location of the well, the gneiss is considered to lie within the Grenville orogenic belt of high-grade, regionally metamorphosed rock.

INTRODUCTION

The Precambrian basement in Ohio is divided into two distinct lithologic provinces by the generally north-south-trending Grenville boundary (Bass, 1960). The western one-third of the basement is composed of igneous and sedimentary

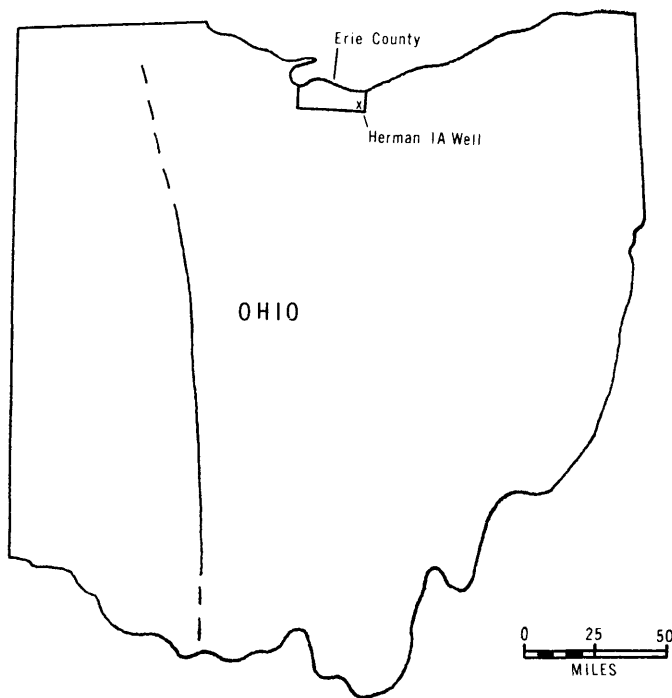


FIGURE 1. Location map of the Herman 1A well. Dashed and solid line represents the Grenville boundary as positioned by Bass (1960).

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rocks which have not been metamorphosed. The eastern two-thirds consists of high-grade, regionally metamorphosed rocks of the Grenville orogenic belt (Bass, 1960). Rubidium-strontium measurements in muscovite and biotite indicate ages of 920 to 980 million years for rocks in the eastern province (Bass, 1960; McCormick, 1961).

The Herman 1A well, from which the core was taken for this study, is located in lot 98 of Florence Township in southeastern Erie County, Ohio (fig. 1). Its location is clearly east of the Grenville boundary as positioned by either Bass (1960) or McCormick (1961). Precambrian quartzo-feldspathic gneiss was encountered from a depth of 4444 feet (elevation -3616) to the bottom of the well at a depth of 4466 feet. This places the basement surface at this locality 37 feet deeper than in the Sayler well four miles to the northwest, and 102 feet shallower than in the Borne well five miles to the northeast (McCormick, 1961). Such an eastward dip agrees with, among others, Summerson's (1962) map of the Precambrian-Paleozoic surface in Ohio.

METHODS

Five samples of core were obtained from the Amerada Petroleum Corporation in 1967. The samples were taken at depths of 4444, 4458, 4462, 4463, and 4465 feet. One thin section was prepared from each sample and stained for plagioclase and potassium feldspar according to the method of Baily and Stevens (1960). A modal analysis based on a count of 1500 points was made for each slide. Plagioclase composition was determined by the Michel-Lévy method, with the aid of a universal stage. Greenish saussuritized plagioclase was the only alteration product counted individually. The thoroughly saussuritized plagioclase will herein be referred to as saussurite which, in these rocks, consists of epidote and calcite. Because the amount of calcite within the saussurite varies considerably, the calcite was counted separately to depict better the nature of the saussurite. This arbitrary distinction between epidote and calcite was made only in the modal analyses (Table 1) and not in the text of this paper.

DESCRIPTION OF THE GNEISS

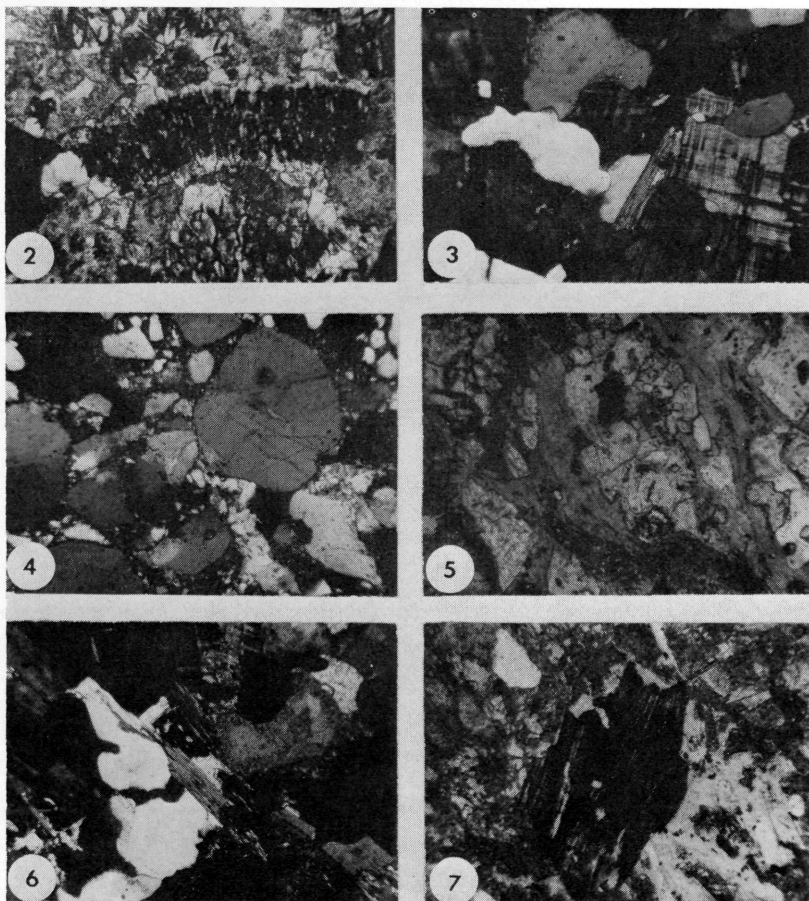
All of the drill-core samples exhibit some degree of gneissosity. Dark layers containing mostly biotite and magnetite tend to be thin (1.0-2.5 mm) and discontinuous. Light-colored layers of quartz and feldspar are usually thicker (2.5-8.0 mm) and more continuous in thin section.

In sample 4444, foliation is more a function of grain size than of composition. In this slide, finer grained quartz-plagioclase layers alternate with coarser grained layers of quartz, plagioclase, and microcline. In contrast, slide 4463 consists of two zones of unlike texture and mineralogy. An area covering two-thirds of the slide contains layers of quartz, feldspars, and saussurite alternating with less distinct layers of biotite and minor magnetite. The remaining one-third of the slide is comprised of elongate grains of secondary magnetite with abundant calcite disseminated along what appears to be relic biotite cleavage traces (fig. 2). These magnetite-calcite bodies impart a foliation to this portion of the slide which is nearly perpendicular to that described above for two-thirds of the slide.

When viewed microscopically, the gneiss is mainly granoblastic (fig. 3). Sample 4444 exhibits well-defined cataclastic texture (fig. 4). In this slide, porphyroclasts of quartz and feldspars are xenoblastic, quite angular, and fractured, with quartz having moderate to intense undulatory extinction. Mineral grains in the ground-mass are also xenoblastic and quite angular.

Major minerals present, in order of decreasing abundance, are microcline, plagioclase, quartz, saussurite, and biotite. These minerals account for approximately 80 percent to nearly 100 percent of the mineralogy in any one sample (Table 1).

Microcline occurs as fresh grains with distinct grid twinning, or as badly fractured and altered grains having faintly visible grid twinning. In all cases microcline is xenoblastic. Some grains show mild undulatory extinction. Sample 4458 contains what appears to be micropertthite in which the plagioclase lamellae were completely saussuritized.



- FIGURE 2. Secondary magnetite with calcite disseminated along relic biotite cleavage traces in sample 4463. $\times 15$.
 FIGURE 3. Granoblastic texture in sample 4462. $\times 15$.
 FIGURE 4. Cataclastic texture in sample 4444. Note angularity and fracturing of grains and undulatory extinction in quartz. $\times 15$.
 FIGURE 5. Saussurite in sample 4463. Light-colored grains are calcite. $\times 15$.
 FIGURE 6. Quartz occupying corroded reentrants in microcline and plagioclase in sample 4462. Also notice the parallel biotite grains in central and lower right portion of photograph. $\times 15$.
 FIGURE 7. Secondary magnetite along biotite cleavage planes in slide 4465. $\times 15$.

Xenoblastic grains of plagioclase (An_{36}) range from relatively fresh to completely saussuritized. Albite twins were clearly visible only in sample 4462, from which the An content (An_{36}) was determined. Plagioclase shows more fracturing and undulatory extinction than does microcline. In sample 4444, plagioclase porphyroclasts tend to be smaller than microcline porphyroclasts.

Three samples (4458, 4463, 4465) contain abundant saussurite consisting of epidote and calcite. Substantial amounts of sericite may also be mixed in with the saussurite. The saussurite is pale green to yellowish green and occurs principally as veinlets passing between and through other minerals (fig. 5). The original plagioclase grains have been altered beyond recognition. Where calcite is present in the saussurite, it commonly occurs as distinct cleavage rhombs surrounded by a fibrous-appearing mixture of epidote and sericite. As would be expected, the same three samples containing the most saussurite contain the least plagioclase (Table 1). Interestingly, they also contain significantly less quartz and substantially more microcline (Table 1).

TABLE 1
Modal analyses of gneiss from the Herman 1A well.

Minerals	Sample 4444	Sample 4458	Sample 4462	Sample 4463	Sample 4465
Microcline	38.1	59.3	25.7	50.0	49.2
Plagioclase	20.8	4.5	49.7	0.1	4.6
Quartz	40.8	4.5	18.5	0.1	3.7
Saussurite	—	18.4	tr.	17.9	30.4
Biotite	tr.	9.0	4.1	12.4	8.7
Calcite	tr.	0.8	tr.	19.4	2.2
Opaque Accessories	tr.	3.0	1.5	tr.	0.6
Nonopaque Accessories	0.2	0.4	0.7	0.1	0.5

Quartz typically forms xenoblastic grains with moderate to intense undulatory extinction. Some larger grains approach a lenticular outline elongated parallel to the foliation. A few quartz porphyroclasts in slide 4444 are also elongate in a similar manner. Quartz characteristically occupies corroded re-entrants in plagioclase and microcline (fig. 6); it also occurs as small grains and as fracture filling.

Xenoblastic to subidioblastic biotite is pleochroic in varying shades of pale brownish-green to dark green and occurs as scattered flakes within the dark layers. Only in slide 4462 does biotite exhibit distinct parallelism to foliation (fig. 6). Some of the biotite in this slide is partially to completely altered to chlorite. Secondary magnetite and hematite are abundant between basal cleavage plates of biotite in slides 4458, 4463, and 4465 (fig. 7). In many instances biotite has completely altered to magnetite with the latter commonly retaining the platy habit of biotite.

Accessory minerals in the gneiss include primary magnetite, pyrite, ilmenite, apatite, zircon, garnet, rutile, and epidote, all occurring as idioblastic or subidioblastic grains.

CONCLUSIONS

The occurrence of Precambrian quartzo-feldspathic gneiss in the Herman 1A well is in general agreement with Precambrian rock types encountered by other drilling in the vicinity. The presence of garnet in two samples (4458 and 4465) and the plagioclase composition of An_{36} (determined in sample 4462) indicate that the level of the amphibolite facies of high-grade regional metamorphism was probably reached. The location and mineralogy of the rock places it within the Grenville orogenic belt forming the Precambrian basement in the eastern two-thirds of Ohio.

ACKNOWLEDGMENTS

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